Research Article

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Comparative Evaluation of the Effect of Topical Fluorides on the Microhardness of Glass Ionomer Cements: An In Vitro Study

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ABSTRACT

Aim: To evaluate and compare the effect of topical fluorides on the micro hardness of conventional glass ionomer cement and light cured glass ionomer cement.

Materials and Method: Fifteen pellets were made of each material and stored in distilled water at room temperature for 48 hours. These were then randomly divided into three subgroups of five pellets each. First subgroup was used as the control group, second group was treated by 4mins application of 1.23 % acidulated phosphate fluoride (APF) gel and third subgroup was treated by 4 min application of 2 % sodium fluoride (NaF) gel. Thereafter, all the pellets were subjected to micro hardness testing (load = 100 g for 15 s).

Result: Microhardness is significantly higher in group II compared to group I for all the samples.

Conclusion: The hardness gained of a restorative material may contribute to the detoriation of the material in a clinical environment leading to increased surface roughness, increased plaque retention, loss of anatomical form and discoloration.

Keywords: Complete Denture Hygiene, Oral health, Oral hygiene practices.

INTRODUCTION

Since their introduction, glass-ionomer cements have gained an established position in restorative dentistry, with a variety of applications. Glass ionomer cements are extensively used as restorative materials in the primary dentition because of their esthetics, biocompatibility, ability to release fluoride, rechargeability, and chemical bonding to enamel and dentine. (1-5) High viscosity conventional glass ionomer cements and resin-modified cements have allowed wider application of these cements because of their properties of decreased moisture sensitivity and improved wear resistance. (4,6)

Restorative filling materials used in dentistry are required to have long-term durability in the oral cavity. One of the most important physical properties of restorative filling materials is surface hardness, which correlates well to compressive strength and abrasion resistance. (7) Glass ionomer cements are capable of acquiring further fluoride ions following exposure to topical fluorides thereby acting as rechargeable fluoride release systems. (8,9)

However, the high reactivity of fluoride agents used in topical fluorides may result in the deterioration of surface properties of esthetic restorative materials. (10,11) This may have implications on clinical durability of restorations. (12,13)

The present study was undertaken in vitro to evaluate and compare the effect of 4 min application of 1.23% acidulated phosphate fluoride (APF) gel and 2% sodium fluoride (NaF) gel on the

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microhardness of conventional and resin-modified glass ionomer cements.

MATERIALS AND METHODS

The materials used in the study were

Restorative materials

Conventional glass ionomer cement

- Fuji II (GC)

Resin-modified glass ionomer cement

- Fuji II LC (GC)

Topical Fluorides

1.23% APF Gel (Nupro, Dentsply)

2% NaF Gel (Nupro, Dentsply)

Distilled Water

Fifteen pellets were made from each material resulting in a total of thirty pellets. The pellets prepared from these restorative materials were mixed or cured according to the manufacturer's instructions. Sufficient amount of materials was placed into an aluminium mould with a specification of 2cm diameter x 3mm thickness, which ensured the standardization of shape and size of each pellet. The light cured pellets were allowed to set at room temperature for 15 min while self cured pellets were allowed to set at room temperature for 24 hours.

The pellets were further divided into following groups

Group I – 15 pellets of Fuji II

Group II – 15 pellets of Fuji II LC

The pellets were then immersed into 2ml of distilled water and stored in an incubator at 37^{0}c for 48 hrs. [17] After 48 hrs, pellets from both the groups were further divided into 3 sub-groups of 5 pellets each.

Sub-group A – Pellets were not treated with any topical fluoride gels and were used as control.

Sub-group B – Each pellet was individually immersed in 2ml of APF gel for 4 min.

Sub-group C – Each pellet was individually immersed in 2ml of NaF gel for 4 min.

After topical fluoride treatment, the pellets were thoroughly rinsed with distilled water and were blot dried. The microhardness tester standardized for Vickers hardness test was used in this study. The testing parameter of 100g for a dwell time of 15s was used and the test was carried out (loading and unloading) in an automated sequence.

Vicker's hardness number (HV) was obtained using the formula:

HV = 1854.4P/d2

Where P equals the applied load in grams and d equals the average length of the diagonal of indentation measured in microns. Two indentations were made on each pellet to obtain the average Vicker's hardness number (HV) of that pellet. [14] The procedure was repeated for all the pellets.

RESULTS

The mean microhardness values were calculated and subjected to statistical analysis.

1) Between Groups Comparisons:

a. Microhardness is significantly higher in group II compared to group I for all the samples (Control, APF Gel, NAF Gel).

2) Within Group Comparisons:

a. In study group I, average microhardness did not differ significantly between APF Gel and NAF Gel samples.

b. In study group I, average microhardness is significantly smaller in control compared to APF Gel and NAF Gel samples.

c. In study group II, average microhardness is significantly smaller in control compared to APF Gel and NAF Gel samples.

d. In study group II, average microhardness is significantly smaller in NAF Gel compared to APF Gel samples.

Table 1: The distribution of average Microhardness according to two main study and three subgroups.

	Study Groups	
Sub Groups	Group I (n=15)	Group II (n=15)
Control (n=5)	47.4 ± 5.2	65.8 ± 3.9
APF Gel (n=5)	70.2 ± 5.8	143.6 ± 3.4
NAF Gel (n=5)	64.2 ± 7.3	73.1 ± 3.5

Values are Mean ± SD of Microhardness (HV).

Table 2: Between group comparison of Microhardness.

Sub Groups	Group I v/s Group II
Control (n=5)	0.008 (Significant)
APF Gel (n=5)	0.009 (Significant)
NAF Gel (n=5)	0.047 (Significant)

Values are p-values, which are obtained by using Mann-Whitney U test. P-values less than 0.05 are considered to be statistically significant.

Table 3: Within group comparison of Microhardness.

	Within Study Group Comparisons		
	Control v/s APF Gel	Control v/s NAF Gel	APF Gel v/s NAF Gel
Group I (n=15)	0.001 (Highly Significant)	0.003 (Significant)	0.316 (Non-Significant)
Group II (n=15)	0.001 (Highly Significant)	0.019 (Significant)	0.001 (Highly Significant)

Values are p-values, which are obtained by using one-way analysis of variance (ANOVA) with Tukey's correction for multiple group comparisons. P-values less than 0.05 are considered to be statistically significant.

DISCUSSION

Glass ionomer cements are clinically accepted preventive restorative materials because of their fluoride releasing property besides their esthetics, biocompatibility, and chemical adhesion to enamel and dentin. Because they release fluoride ions, they are particularly useful where cariostatic action is needed. Recent introduction of high viscosity conventional glass ionomer cements and resin-modified glass ionomer cements has allowed a wider application of these cements.

Figure 1: The comparison of Microhardness across two main study and three subgroups.

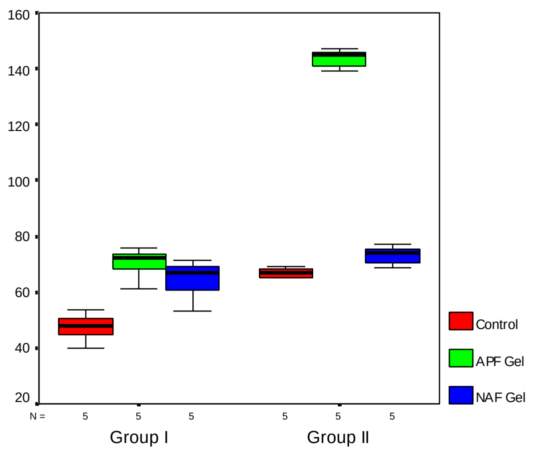
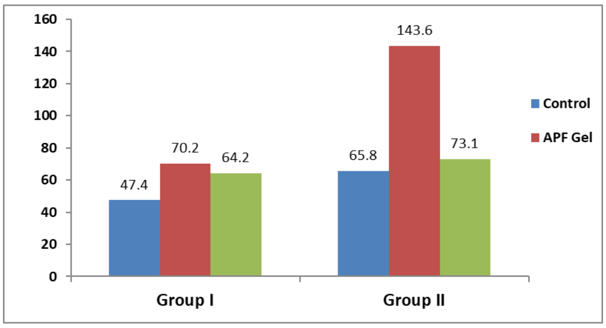


Figure 2: The comparison of Microhardness across two main study and three subgroups.



Topical fluorides are without doubt an important part of preventive dental therapy. Fluoride inhibits demineralization and promotes remineralization, thus encouraging repair or arrest of carious lesions. Topical fluorides can also recharge the fluoride content of exhausted glass ionomer cements, thus converting them into fluoride reservoirs.

Conventional glass ionomer cements consist of basic glass and an acidic polymer, which sets by an acid-base reaction between these components. [15]

In resin modified glass ionomer cements polymerizable functional groups are added to impart more rapid curing when activated by light to overcome the inherent drawbacks of moisture sensitivity and low early strength of conventional glass ionomer cements. They allow acid-base reaction to take its course long after polymerization is complete. [16]

APF gel 1.23% (pH 3.5) and NaF gel 2% (pH 7) were used in this study since these are the American Dental Association recommended specifications for professionally applied topical fluorides. [17] Four minute treatment time of topical fluoride application was used as this time has been recommended for professionally applied topical fluoride solutions, gels or foams. [18]

Surface hardness is defined as resistance to indentation and is influenced by the material's strength, proportional limit, ductility, malleability, and resistance to abrasion and cutting. [19] One of these properties that have clinical relevance is its resistance to abrasion or wear. Hardness measurements allow relative determination of this behaviour. [16]

Vicker's microhardness test was used in this study as this test is suitable for determining the hardness of brittle materials. [16]

In the present study, 1.23% APF gel applied for 4min produced statistically significant increase in the microhardness values of both the materials tested as compared to control subgroups.

One of the components of the APF gel is phosphoric acid, which is meant to etch the enamel and thereby enhance fluoride uptake. A number of studies have shown that phosphoric acid significantly alters the surface morphology of various restorative materials leading to changes in the physical properties, such as hardness, roughness, and erosion resistance. [10,11,20]

The decrease in microhardness was more pronounced in conventional glass ionomer restorative materials and least pronounced in resin-modifeied glass ionomer cements after APF treatment in this study.These findings are in concurrence with studies of El-Badrawy and McComb, [22] Abate et al, [23] and Setty et al. [14]

Neutral NaF gel 2 % (ph 7) applied for 4 min produced staticsally significant increase in microhardness values of both the tested materials as compared with the control subgroups in the present study.

Statistically highly significant difference in microhardness was observed in both the restorative materials treated with APF gel as compared with NaF gel in this study. Diaz-Arnold [12] reported that neutral NaF recharges glass ionomer cements, while maintaining the integrity of the restorations, although the amount of fluoride release after neutral NaF treatment is not high as compared with APF treatment.

The results of the present study suggested that 1.23% APF gel applied for 4 min produces more detrimental effect as compared with 2% NaF gel applied for 4 min on the microhardness of the restorative material tested.

The hardness gained of a restorative material may contribute to the detoriation of the material in a clinical environment leading to increased surface roughness, increased plaque retention, loss of anatomical form and discoloration. This may significantly shorten the life span of the restoration.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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